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Report Title

Charge Transport and Optical Properties in Silicon Quantum Dot Arrays

ABSTRACT

The size dependence of the dielectric function of silicon quantum dots and quantum sheets has been determined using spectroscopic ellipsometry in the photon energy range from 0.73 eV to 4.58eV. The quantum dot/sheet size was varied from greater than 10nm (where the dielectric function is expected to be close to that of bulk silicon) to below 2nm (where theory predicts a decrease due to quantum confinement and/or breaking of polarizable bonds at the dot surface). The ellipsometric measurements were performed at room temperature and correlated with several techniques. A dramatic lowering in the real and imaginary parts of the dielectric function was observed for sized below 3.3 nm. The decrease is much more pronounced than predicted by theory and must be considered when designing optical and electrical devices such as light emitting devices, non-volatile memory devices and singe electron transistors.

List of papers submitted or published that acknowledge ARO support during this reporting period. List the papers, including journal references, in the following categories:

(a) Papers published in peer-reviewed journals (N/A for none)

"Light Emission From Si Quantum Dots" P.M. Fauchet, Materials Today, January 2005, pp 26-33 (Invited)

"The Development of Nanocrystalline Silicon for Emerging Microelectronic and Nanoelectronic Applications" C.C. Striemer, R. Krishnan and P.M. Fauchet, Journal of Materials 56 (10), pp 20-25 (2004)

Number of Papers published in peer-reviewed journals: 2.00

(b) Papers published in non-peer-reviewed journals or in conference proceedings (N/A for none)

"Charge Transport In Silicon Nanocrystal Arrays" R. Krishnan, Q. Xie, J. Kulik, X.D. Wang, T.D. Krause and P.M. Fauchet, Mat. Res. Soc. Symp Proc. 832, 201-205 (2005)

Number of Papers published in non peer-reviewed journals: 1.00

(c) Presentations

"Nanoscale and Nanostructured Silicon for Optoelectronics" Invited Presentation at the International conference on Polycrystalline Semiconductors 2004, September 10, 2004, Potsdam, Germany

Number of Presentations: 1.00

Non Peer-Reviewed Conference Proceeding publications (other than abstracts):

Number of Non Peer-Reviewed Conference Proceeding publications (other than abstracts): 0

Peer-Reviewed Conference Proceeding publications (other than abstracts):

Number of Peer-Reviewed Conference Proceeding publications (other than abstracts): 3

(d) Manuscripts

Dielectric constant suppression in silicon nanostructures, H.G. Yoo, R. Krishnan, and P.M. Fauchet, submitted to Phys. Rev. Lett.

Number of Manuscripts: 1.00

Number of Inventions:

Graduate Students

NAME	PERCENT_SUPPORTED
Han Yoo	0.25
Rishi Krishnan	0.50
Sean Anderson	0.25
FTE Equivalent:	**1.00**
Total Number:	**3**

Names of Post Doctorates

NAME	PERCENT_SUPPORTED
FTE Equivalent:	
Total Number:	

Names of Faculty Supported

NAME	PERCENT_SUPPORTED	National Academy Member
Philippe Fauchet	0.10	No
FTE Equivalent:	**0.10**	
Total Number:	**1**	

Names of Under Graduate students supported

NAME	PERCENT_SUPPORTED
FTE Equivalent:	
Total Number:	

Student Metrics

This section only applies to graduating undergraduates supported by this agreement in this reporting period

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The number of undergraduates funded by this agreement who graduated during this period with a degree in science, mathematics, engineering, or technology fields:.....	0.00
The number of undergraduates funded by your agreement who graduated during this period and will continue to pursue a graduate or Ph.D. degree in science, mathematics, engineering, or technology fields:.....	0.00
Number of graduating undergraduates who achieved a 3.5 GPA to 4.0 (4.0 max scale):	0.00
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Names of Personnel receiving masters degrees

NAME
Total Number:

Names of personnel receiving PHDs

NAME
Rishiu Krishnan
Total Number: 1

Names of other research staff

NAME	PERCENT_SUPPORTED
FTE Equivalent:	
Total Number:	

Sub Contractors (DD882)

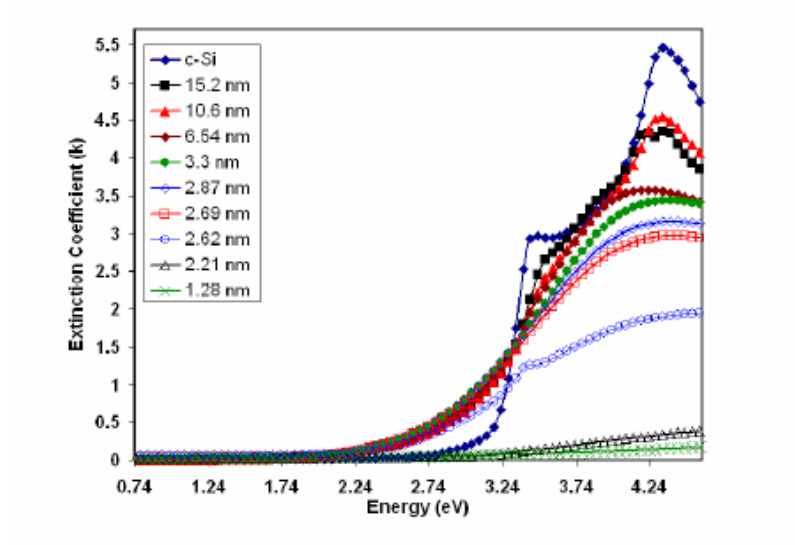
Inventions (DD882)

Dielectric Properties of Silicon Quantum Dots

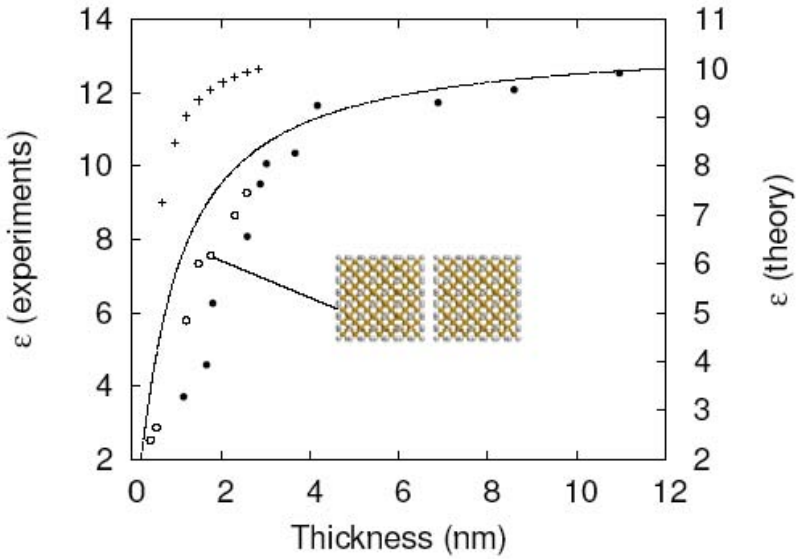
P.M. Fauchet, Univ. of Rochester DAAD190310267

Si quantum dots of precisely controlled sizes from ≥ 10 nm to < 2 nm are prepared by depositing a-Si/SiO_2 superlattices by rf magnetron sputtering followed by annealing to crystallize the a-Si layers.

We observe a very steep decrease of the dielectric constant or refractive index of the Si quantum dots for sizes below 4 nm. The decrease is much more pronounced than predicted by theory. Theory and experiments can be approximately reconciled only by assuming a 0.4 nm void space between the quantum dots, an assumption that is not supported by measurements performed on the film.



The precise size control is reflected in this measurement of the extinction coefficient of Si quantum dots. The results are obtained by spectroscopic ellipsometry



Experimental data (full circles) and quantum dot theory (crosses) for the dielectric constant of Si quantum dots. The full line and the open circles assume void between the dots and bulk dielectric constant and quantum dot theory, respectively